ENERGY $AVER$
"... For Business and Industry".
VOLUME TWO / NO. 1

SIMPLE STEPS TO VENTILATION SAVINGS

The Facts...

Most buildings need a continuous supply of fresh air during occupied hours to make them healthy, comfortable areas in which to live and work. Moving, heating, cooling and conditioning this fresh air takes energy (in the form of natural gas and electricity) and the associated energy dollars.

According to the Alberta Energy Bus energy audit database, 20 to 40 per cent of the natural gas consumed in audited facilities is used for ventilation. The Energy Bus program has often found ventilation rates far exceeding ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) guidelines for fresh outside air.

In many buildings, more air than necessary is supplied and removed. Controlling the volume of cold outside air to be heated is the key to ventilation cost savings.

Most mechanical ventilation systems control the flow of outside air using one of two control methods. One varies the volume of fresh air brought into the facility so that a constant mixed-air (outside air and return air) temperature is maintained, normally between 45°F (7°C) and 55°F (13°C). The other maintains a constant volume of air from the outside.

Based on these methods, two cost-effective measures can readily be implemented to reduce the volume of outside air to be heated.

One method is to raise the mixed-air temperature setting, reducing the temperature difference between the mixed air and the air supplied to a particular area. As a result, less outside air is drawn in and more return air is circulated. Savings are achieved because less energy is needed to raise the temperature of the mixed air to that desired within the building.

Outside air inlet dampers regulate the volume of air by modulating from 100 per cent open, down to a minimum open position. The actual position of the damper depends on the outside air temperature. The savings by increasing the mixed-air temperature from 50°F (10°C) to 55°F (13°C) is about 25 per cent.

Air control dampers set in minimum position.

A second way to save on ventilation costs is to convert a constant mixed-air temperature system to a constant outside air volume system when the outside air temperature drops below a preset value. The preset value (or balance point temperature) is the outside air temperature at which the internal heat gain from lights, equipment and people within a building equals heat loss. Below the preset temperature, the outside air damper closes to the minimum position (for example, 20 per cent open). It stays in this position until the outside air temperature rises above the preset temperature, at which time the ventilation system is again controlled by the constant mixed-air system.

The greatest savings occur when the outside temperature is just below the value at which the system converts to a constant outside air volume system. When this conversion occurs, the mixed-air temperature increases noticeably. For instance, at an outside temperature of 42°F (6°C), the potential saving by converting a constant mixed-air temperature system to a constant volume system is about 60 per cent. The percentage savings will decrease gradually as the outside temperature drops.

Increasing the mixed-air temperature can be simple and inexpensive. Most ventilation systems have an existing thermostat to control the mixed-air setting. The cost of changing the thermostat setting should be minimal as it can usually be done by a building operator. The setting must be changed about four times a year (spring, summer, fall and winter). Building owners and operators should be aware that with drastic changes in outside temperature, the set point may have to be adjusted accordingly. For example, during a chinook, a sudden rise in outside temperature may cause overheating.

A constant outside air volume system is more complex to implement. Building operators must invest in additional control components: at a minimum, a thermostat, a solenoid valve (that switches between control systems) and a minimum position controller.

Depending on the type of system (i.e. pneumatic, electronic or a combination of the two), the cost of materials will likely be between $500 and $1500. The cost depends on the location and accessibility of the control panel relative to the equipment. A control system specialist should be consulted for a cost estimate and advice on making the modifications.

Maintaining a safe and comfortable working environment need not be costly. Good ventilation can be obtained and cost savings realized by implementing these few simple control measures.

The Application...

Eastglen Composite High School in Edmonton is a large two-storey building with 169 300 square feet (15 730 square metres) of floor area. Built in 1953, with additions in 1957 and 1961, the school's facilities include an industrial arts wing, two gymnasiums, an auditorium and library, offices and two floors of classrooms.

Designed to accommodate up to 1200 students, the school has averaged 850 students from 1980 to 1988.

In June 1983, Eckhart Stoyke, energy consultant with Edmonton Public Schools, requested an energy audit of Eastglen by Alberta's Energy Bus program to evaluate energy use in the school. At the time of the audit, the school's ventilation units and exhaust fans operated to match building occupancy, i.e. the system was turned off at midnight and on at 6:00 a.m. (The school is used for adult education courses and other evening activities.)

The ventilation systems included two main units for the classrooms, an auditorium supply unit, gym units, and shop supply and exhaust. Following the audit, Stoyke hired a consulting engineer to undertake feasibility evaluations and design work. In August 1984, as recommended by the consultant, the controls on the two main units and the auditorium unit were modified so that at 43°F (6°C) and below, the system would convert to a constant outside air volume system. Above 43°F (6°C), it is controlled by a constant mixed-air temperature set at 60°F (15.5°C).

After modification, the school's annual natural gas consumption for 1984/1985 showed a dramatic reduction of 26 per cent. The school's natural gas consumption data for an eight-year period (1980 to 1988) shows long-term average savings of about 18 per cent when the four-year average consumption prior to the modification is compared with the four-year average after. At current energy prices, this translates into a saving of about $10 000 per year.

At Eastglen Composite High School, three systems were modified at a cost of about $9000. With an annual saving of nearly $10 000, the payback period on the modifications is calculated as follows: capital cost divided by net savings, multiplied by 12 months of the year =

$$\frac{9000}{10\,000} \times 12 = 11 \text{ months.}$$

The Bottom Line...

Simple steps can lead to significant ventilation cost savings for building owners and operators in Alberta. They can also yield a good return on investment, depending on the necessary modifications. To determine whether an energy saving measure is cost effective, divide the cost of implementing the measure by the annual savings, multiplied by 12 months, to obtain the payback period (the number of months required to recover the investment).

The cost of increasing the mixed-air temperature will be minimal because the adjustment to the thermostat can be done by most building operators.

The payback period for converting to a constant outside volume system will vary depending on the modifications and the number of additional components. The material costs generally range between $500 to $1500.

By using the accompanying graph, building owners and operators can determine the potential annual savings for their particular ventilation system. Two examples of existing and proposed ventilation system conditions show how the graph can be used to determine annual energy use, expressed in gigajoules of natural gas per cubic feet per minute of ventilation air per year (GJ/cfm/yr.). The following formula is used to calculate the savings:

Annual savings =
[existing energy use (GJ/cfm/yr.)
− proposed energy (GJ/cfm/yr.)]
× cfm × $/GJ

To obtain the energy use for the existing conditions, read up from 80 hours per week to the T_{mix} = 50°F (10°C) line and across to the left to the vertical axis. Energy use, in this case, will be 0.108 GJ/cfm/yr.

To determine the energy use for the proposed conditions, read up from 80

hours per week on the horizontal axis to the T_{mix} = 55°F (13°C) line and across to the left. Under these conditions, the proposed energy use will be 0.083 GJ/cfm/yr. The estimated savings can be calculated as follows:

Annual savings =
(0.108 – 0.083) GJ/cfm/yr × 6000 cfm × $2.12/GJ = $318 per year

In Example 2, the existing conditions are the same, so energy use remains at 0.108 GJ/cfm/yr. To obtain the energy use for the proposed conditions, read up from 80 hours per week to the constant O.A. = 45°F (7°C) line and across to the left. The proposed energy use will be 0.062 GJ/cfm/yr.

Annual savings =
(0.108 – 0.062) GJ/cfm/yr × 6000 cfm × $2.12/GJ = $585 per year

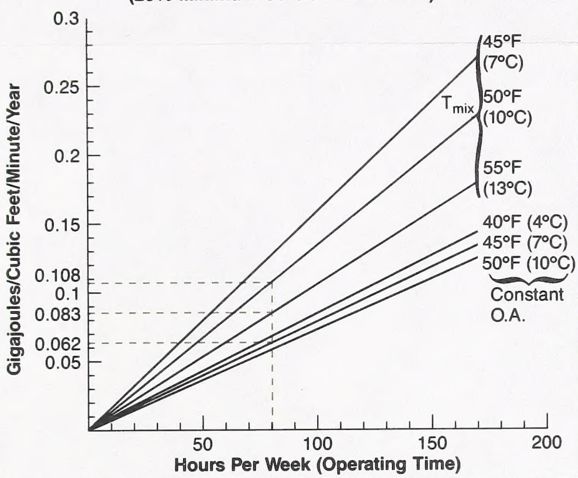
Building owners and operators can use the graph and formula for their ventilation system by knowing the following factors:

- fan supply volume (from air balance report or by measurement).
- natural gas price, including taxes and rebate (from the local gas utility).
- hours of operation of the fan system.

FIGURE 1

Energy Use For Ventilation Systems

(20% Minimum Outside Air Volume)



EXAMPLE 1

Existing Conditions:
Mixed-air temperature (T_{mix}) = 50°F (10°C)
Fan Volume = 6000 cubic feet per minute (cfm) (2832 litres per second)
Gas cost = $2.12 per gigajoule (GJ)
Operating hours = 80 hours per week
Minimum outside air = 20 per cent

Proposed Conditions:
Mixed-air temperature (T_{mix}) = 55°F (13°C)

EXAMPLE 2

Existing Conditions: See Example 1

Proposed Conditions:
When the outside air (O.A.) temperature is less than or equal to 45°F (7°C), the system converts to constant outside air of 20 per cent

When the outside air temperature is greater than 45°F (7°C), the system converts to T_{mix} set at 55°F (13°C).

SECTOR REVIEW

Energy Use in Secondary Schools

Energy use varies widely depending on the type of building and the activities in the building. The variety of energy use has become evident following Energy Bus audits of almost every type of facility in Alberta.

An energy audit determines how energy is being used and how much it costs in each area. Energy conservation measures are then identified which may result in energy cost savings. On average, the Energy Bus has identified a potential reduction in energy cost of about 20 per cent.

Figure 2 shows energy use in kilowatt hours per square foot per year (and per square metre) for electricity and natural gas used in the 27 secondary schools visited by Alberta's Energy Bus. Most junior and senior high schools are fully used 40 hours per week, 10 months of the year. During the rest of the time, the schools have minimal use.

Figure 2 also compares the use of energy and its associated costs in secondary schools. In Alberta, natural gas is the least expensive energy source. The average price of a unit of electrical energy is four to five times that of the equivalent unit of natural gas. Therefore, when analysing energy use, the associated energy costs must be considered.

Energy Use & Cost in Secondary Schools

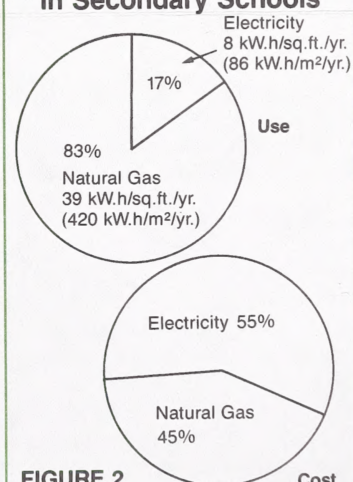


FIGURE 2

Figure 3 shows how electrical and natural gas energy is used in secondary schools. Air handling systems (ventilation, exhaust and supply) use 23 per cent of the electrical energy, primarily to move air with the fan systems, and 30 per cent of the natural gas energy to condition the air by heating.

As shown in Figure 4, Energy Bus audits have identified substantial cost saving potential through reduction of ventilation levels while maintaining acceptable levels of air change. The potential for natural gas savings (66 per cent) is greater than the potential for electrical savings (12 per cent) because the natural gas savings include a number of energy-efficiency measures (e.g. reduced operating hours and reduced air flow volumes) but the electrical cost savings are associated with reduced operating hours only.

During follow-up contacts with each audited secondary school a year-and-a-half after the initial audit, it was determined that over 60 per cent of the potential savings identified are obtained through implementation of energy-saving measures as shown in the lined section of Figure 4.

Energy Use in Secondary Schools

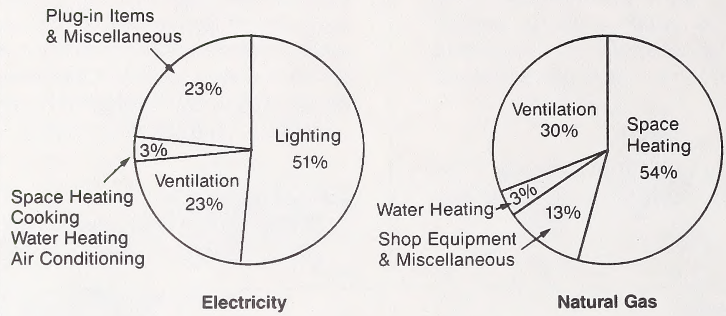


FIGURE 3

Cost Saving Potential Through Reduction of Ventilation Levels in Secondary Schools

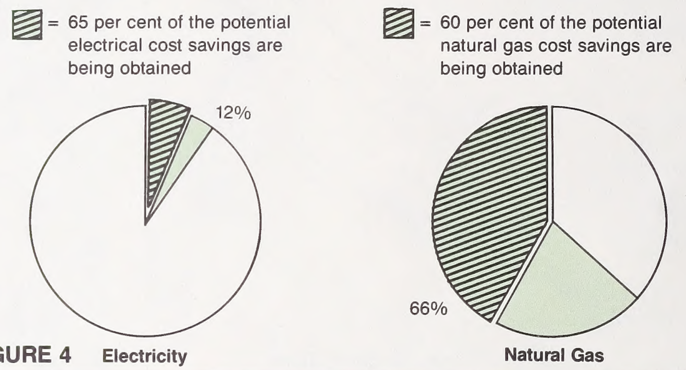


FIGURE 4

FOR MORE INFORMATION

The article Simple Steps To Ventilation Savings was researched by Brian Weir and the Sector Review was completed by Les Sladen. For detailed information on energy cost saving calculations and the energy audit database, contact the industrial section of the Energy Efficiency Branch: Phone 427-5200 (collect).

ENERGY $AVER$

Energy $aver$ is a series of fact sheets about energy conservation measures that have wide application in Alberta. Each issue highlights a different technology and its successful use in the province. The Sector Review summarizes energy use patterns of different facilities that have used the Alberta Energy Bus audit service. Comments, questions and suggestions are welcome.

Write or phone (collect) to be placed on the mailing list. You may also obtain Energy $aver$ back issues or arrange for an Energy Bus audit (conducted at no charge).

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